Space Weather Technical Forecast

Issued on Monday, 04 July 2022 at 13:03 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated G1/Minor Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with X-ray activity peaking with a C3.2 flare at 03/1954UTC from Ex-AR3040, now rotated beyond view at the west limb.

There are now five numbered sunspot groups on the sun, with the partition of AR3046 in the period to a leading Hsx portion and now also a trailing Bxi/Beta, now numbered AR3050. All of these sunspots were small, inactive, stable or in decay, with the sole exception of the newly-numbered AR3051 in the northeast, which grew from plage to attain Cro/Beta classification in the 24 hours.

A filament that previously straddled the solar meridian in the southern solar hemisphere became mobile during the UTC evening of 03 July, disappearing around the turn of the UTC day. This has been tentatively linked with a narrow, apparently southward-heading Coronal Mass Ejection (CME) in Lasco C2 and STEREO A COR2 imagery, with cursory analysis suggesting that this is unlikely to affect Earth. No Earth-directed CMEs have been observed in available imagery.

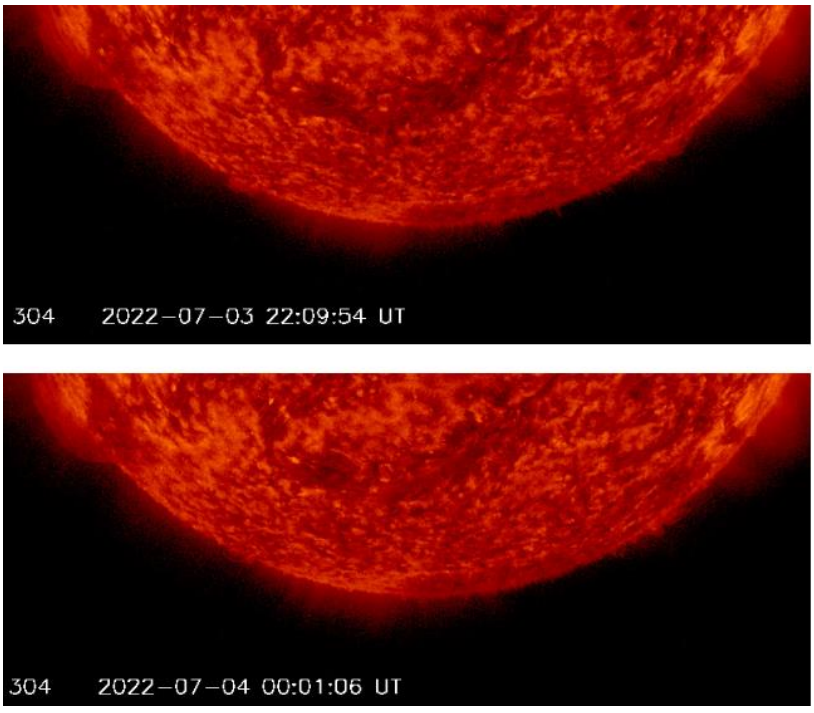

Figure 0: AIA 304 images of changes in the central southern hemisphere filament either side of UTC midnight. A tentaively linked resultant CME appears to miss Earth to the south and west.

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Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1 by DSCOVR, showed some enhancement in the period. The cause of this is uncertain, but perhaps fits either a CIR, with a similar high teens nT IMF seen at STEREO two days ago; or failing that a minor transient, with the Bz component showing some smooth sinusoid features in the period. The former is probably the preferred explanation at present, but this will become clearer in the coming hours.

Despite the above enhancement, the solar wind speed was within its normal background range, with an erratic, overall rising trend between 300 and 400km/s that started in earnest after slight discontinuities at 03/1900UTC. The solar wind density was also erratic, but often significantly above background, with a peak of 60ppcc around 04/0400UTC, beginning to fall away as the period ended. The IMF was elevated at a peak of 20nT, while the north-south component ranged between +17 and -13nT, as already stated with a roughly sinusoidal character that increased in amplitude with time. The phi angle was mainly negative (towards the sun).

Unless this phi angle changes shortly, CH97/+ and its CIR is not the cause of current activity - a more minor negative polarity feature perhaps instead being the culprit (CH96/-, although this has been dropped from recent analyses for being too faint).

The net effect of the above solar wind measures was provisionally mainly Unsettled, with a peak Kp of 4+ in the 03-06UTC window that was later adjusted to 5- once more data became available (i.e. Minor Storm G1).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) as measured by GOES16 remained at Background levels throughout the period.

The high energy electron flux (greater than 2MeV) has been at Normal Background levels through the last 24 hours. Electron fluence was well below the Active (1e8 integrated pfu) threshold. Observed fluence was 1.63e6 integrated pfu at 04/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low or Very Low at first given the current dearth of significant front-sided spots. An uptick in activity is probable from the middle of the week as returning regions potentially cross onto the eastern limb.

Solar Wind / Geomagnetic Activity: A possible slow CME from 29 June may reach Earth on Day 2 (Tuesday 05 July), however confidence is very low given the slow emission speed, with no significant impacts currently anticipated. No other Earth-directed CMEs feature.

The next main enhancement is likely to come from the northern CH97/+, which is a much larger and wider feature than on the previous rotation. There is some uncertainty on potential arrival time (perhaps being imminent if current enhancements are linked to its CIR), but later on Tuesday 05 June is otherwise the estimate. There is also a low chance of an enhancement at Earth prior to the anticipated CH97 from a previously-analysed smaller coronal hole (CH96/-) in the southwest quadrant. The phi angle has yet to settle in the current CIR-like feature, and which, if either hypothesis above is correct remains to be seen, with low confidence.

Depending on the cause of the current feature, geomagnetic activity is likely to progress from Unsettled, with an increased chance of Active periods and a Chance of isolated G1/Minor Storms. This should all occur to peak by late Tuesday 05 June and into Wednesday 06, however there is a chance that this may already be in course, in which case activity will play out sooner. Quieter conditions may also begin to re-develop by the end of the period if the fast wind is already occurring.

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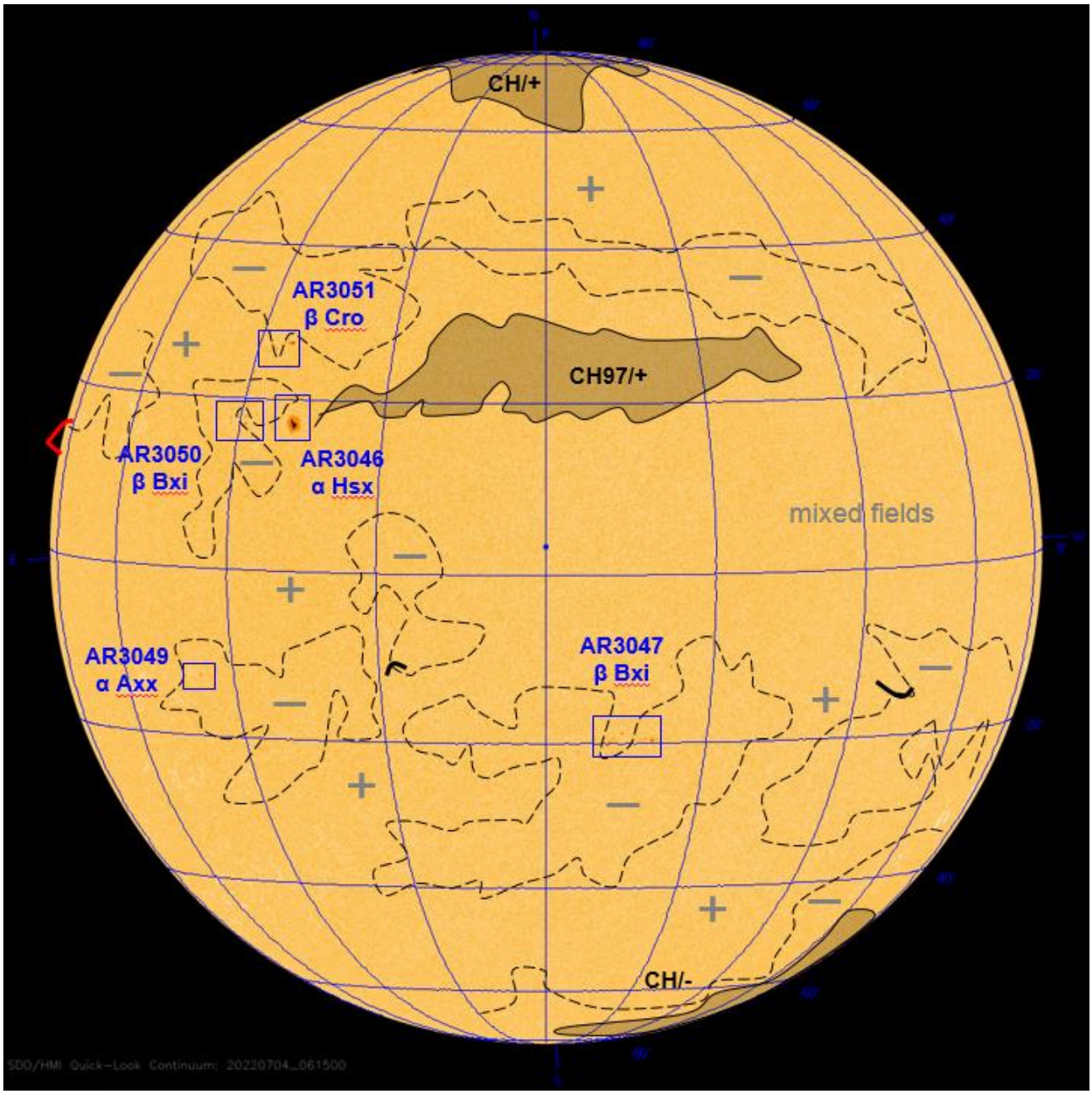
Energetic Particles / Solar Radiation: In the absence of any significant sunspot development, the high energy proton flux (greater than 10 MeV) is expected to remain at Background levels.

High energy electron flux (greater than 2MeV) is expected to be mainly Normal Background at first. However, there is a likely increasing chance of high (1e3 pfu) flux levels being reached during the forecast period due to anticipated high speed stream influence. Electron fluence is considered most likely to remain below the Active (1e8 integrated pfu) threshold, but with an anticipated rising trend.

Figure 1. Solar Analysis Valid 04/0615UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A possible slow CME from 29 June may reach Earth on Day 2 (Tuesday 05 July), however confidence is very low with no significant impacts currently anticipated given the slow speed and lengthy transit time involved. No other Earth-directed CMEs feature in the forecast.

Relative to earlier guidance, the risks of G1 have been progressed forwards in time slightly to account for the possibility that the current enhanced solar wind stems from CH97/+, perhaps even with an element of the 29 July CME swept up in it. For this to be the cause, the phi angle must shortly transition to become positive, however the fact that the scale of the enhancement is relatively large (as expected from CH97/+) and that the feature appeared in some form at STEREO A two days ago, perhaps lend this rationale the most weight.

Other hypotheses are that it is a CIR from CH96/-, with the phi angle correct, but the scale of the feature perhaps larger than expected; else a CME, given the at times smoothly-varying Bz trace (perhaps stemming from 28 June, otherwise perhaps the slow 29 June CME being collected by a CIR).

All considered, Unsettled acvitity should be most frequent, with active intervals Likely and a Chance of G1 at peak into day two, Tuesday 05 June. The chances of G1 intervals continuing through to Day 4 are slightly reduced given the possible observed early start to activity.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	30	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
29/1903	Partial	Filament	N18W000	200km/s	Tuesday 05 July	Very low confidence

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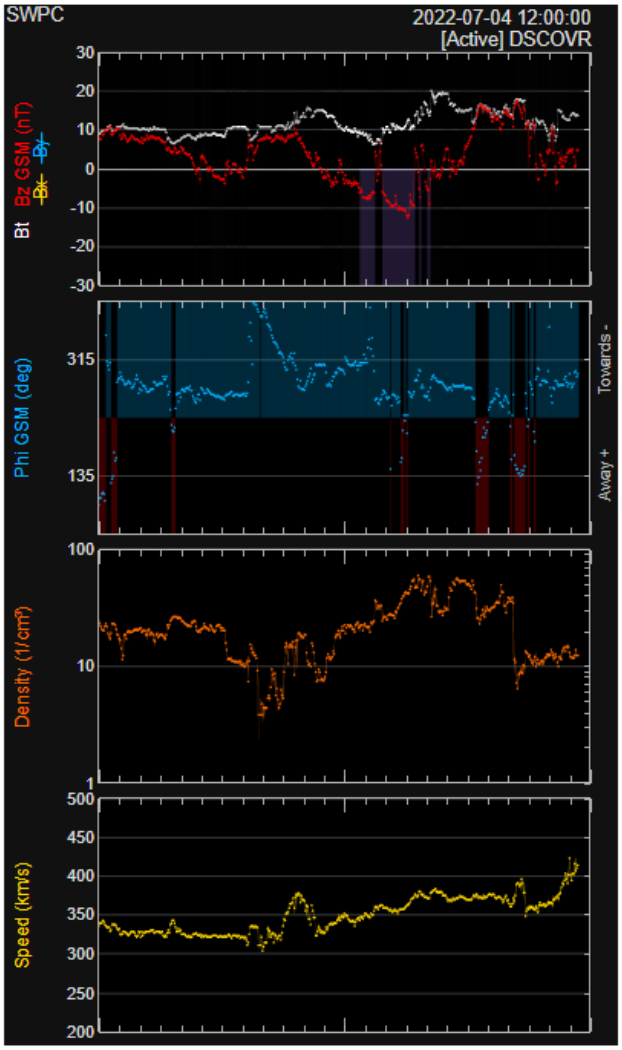
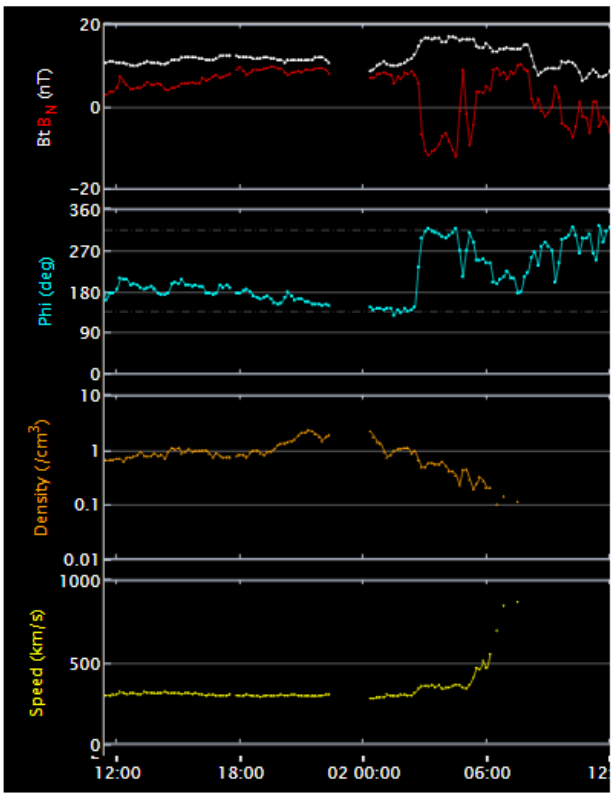
Figure 2: Past 24 hours in solar wind measures at L1 (DSCOVR and ACE, left); compared with relevant analog period at STEREO A (right). While the scales and details do differ, there are enough similarities to perhaps suggest a persistent feature is reponsible for current activity at Earth, perhaps with some pollution from a transient at Earth.





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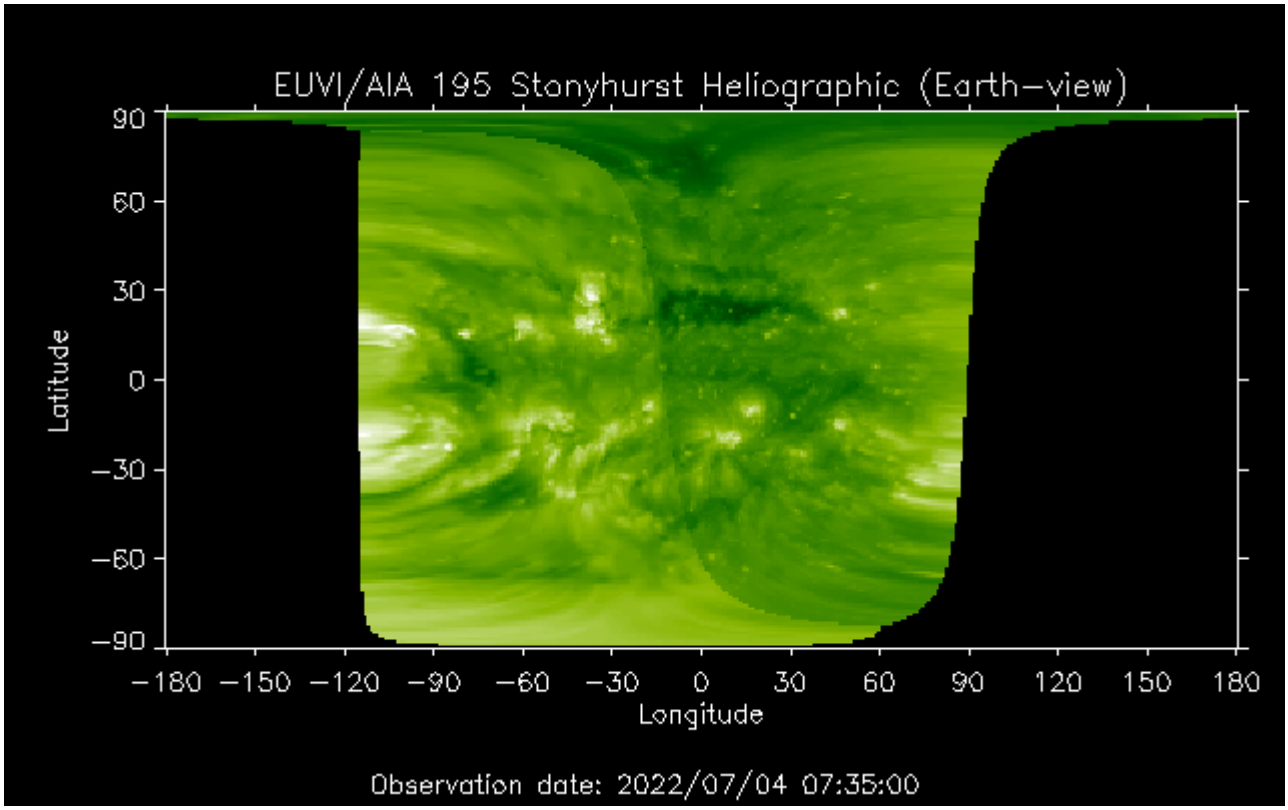
Radio Blackouts - X-Ray Flares:

Solar activity increased to Low following a C3.2 flare at 03/1954UTC from Ex-AR3040, with this region now rotated beyond view over the western limb. The five remaining sunspot regions are all relatively simple in character, and are considered unlikely to generate significant activity in their current guise.

A couple of bright flux regions are apparent near the eastern limb of STEREO A EUVI imagery which may correspond to possible returning regions which are likely to rotate onto the Earth-facing disc around midweek. The outlook is therefore for a greater risk of flares with time, however the degree to which this occurs will be assessed after any arrivals over the eastern horizon.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Cylindrical projection of the disc in 195 Angstroms, as viewed from L1 and STEREO A, suggesting bright flux regions are due over the eastern limb in the four-day period.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at background levels, and will most likely remain at this level through the period, in the absence of any significant sunspot development.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) has been at mainly background levels. Electron flux is likely to oscillate between background and moderate levels, at least initially. However, there is a likely increasing chance of high (1e3 pfu) flux levels being reached during the forecast period due to anticipated high speed stream influence. This has been moved forward in time slightly to account for the possible early onset of CH97/+.

Electron fluence is currently well below the Active threshold. Fluence is currently considered most likely to remain below the Active threshold through the period, although this carries a degree of uncertainty due to the significant difference in coronal hole extent compared to the previous rotation. An upward trend is assessed as being likely following anticipated coronal hole connection but with low confidence for the magnitude of this.

Recurrence is not considered to be a very good guide at present, and REFM maintains very low Fluence values, with no upward trend, which may be a little deficient.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	10	30	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	5	5

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